NEWSLETTER 49

Summer 2019

EUROPEAN MECHANICS SOCIETY

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EUROMECH Conference Reports

EMMC16 – 16th European Mechanics of Materials Conference

26 - 28 March 2018, Nantes, France
Chairperson: Prof. Laurent Stainier

Introduction

The 16th European Mechanics of Materials Conference (EMMC16) gathered researchers sharing a common interest in the field of mechanics of materials, yet working in a variety of application domains. These included materials science, mechanical and civil engineering, as well as biomechanics and geophysics. Contributions providing a better understanding of complex phenomena associated with the mechanical response of materials at all scales, from atomistic to structural sizes, were presented. The scope of the conference covered experimental, analytical and computational modelling approaches. Contributions combining several approaches were specially encouraged.

Delegates

EMMC16 hosted 324 delegates, originating from the following countries: France (145), Germany (53), Belgium (21), Netherlands (16), UK (15), Spain (11), Italy (7), Switzerland (7), United States (7), India (5), Israel (5), Russia (4), China (3), Sweden (3), Austria (2), Canada (2), Czech Republic (2), Denmark (2), Ireland (2), Luxembourg (2), Norway (2), Australia, Croatia, Iran, Oman, Portugal, Singapore, South Korea, Ukraine.

Plenary Lecturers

Three plenary lecturers (selected by the EMMC scientific committee) were invited:

- Prof. Dennis KOCHMANN (ETH Zurich, Switzerland), "To Switch or Not to Switch – Bridging Across Scales in Ferroelectric Ceramics";
- Prof. Dierk RAABE (MPIE, Dusseldorf, Germany), "Chemo-mechanics of metallic alloys";
- Prof. Thomas PARDOEN (UC Louvain, Belgium), "Micromechanics of deformation and fracture in highly cross-linked thermosets".

Parallel sessions

22 thematic parallel sessions, on topics selected by the scientific committee, were coordinated by appointed session organisers (numbers indicated below do not include accepted papers which were later cancelled). The chairpersons and number of presentations in each session are indicated, together with the number of papers included in the EUROMECH Best Student Presentation Award session.

- S1: Mechanics of polymers and metallic glasses - Experiments and models
  - Rafael Estevez (INP Grenoble, France), Hans van Dommelen (TU Eindhoven, NL)
  - 10 presentations (+4 in the Award session)
- S2: Mechanics of composites - Experiments and models
  - Soraia Pimenta (Imperial College, UK), Carlos Gonzalez (IMDEA Madrid, Spain)
  - 17 presentations (+1 in the Award session)
- S3: Mechanics of metals - Experiments and models
  - Ron Peerlings (TU Eindhoven, NL), Erica Lilleoden (HZ Geesthacht, Germany)
  - 26 presentations (+4 in the Award session)
- S4: Mechanics of ceramics - Experiments and modes
  - Davide Bigoni (Univ. Trento, Italy), Nicolas Schmitt (LMT Cachan, France)
  - 5 presentations
- S5: Additive Manufacturing
  - Aude Simar (UC Louvain, Belgium), Rémy Dendievel (SIMAP Grenoble, France)
  - 12 presentations
- S6: Ductile damage and fracture
  - Thomas Pardoen (UC Louvain, Belgium), Kim Lau Nielsen (DTU Lyngby, Denmark)
  - 19 presentations (+3 in the Award session)
- S7: Fatigue, reliability and lifetime predictions
  - Nicolas Saintier (ENSAM Bordeaux, France), Fionn Dunne (Imperial College, UK)
  - 11 presentations (+1 in the Award session)
- S8: Failure of quasi-brittle materials
  - Claudia Comi (Politecnico Milano, Italy), Bert Sluys (TU Delft, NL)
  - 12 presentations (+1 in the Award session)
- S9: Functional and architectured materials
  - Stephan Rudykh (Univ. Wisconsin-Madison, USA), Jörg Schröder (Univ. Duisburg-Essen, Germany)
  - 11 presentations (+1 in the Award session)
- S10: Coupled problems in material mechanics
  - Laurence Brassart (Monash Univ, Australia), Andreas Menzel (TU Dortmund, Germany)
  - 12 presentations (+3 in the Award session)
- S11: Mechanics of biological materials & biomechanics

- Vikram Deshpande (Cambridge, UK), Christian Gasser (KTH Stockholm, Sweden)
- 9 presentations (+2 in the Award session)

- S12: Mechanics of interfaces and evolving microstructures
  - Paul Steinmann (Univ. Erlangen, Germany), Roland Logé (EPFL, Switzerland)
  - 8 presentations
- S13: Mechanics of discrete systems
  - Jean-François Molinari (EPFL, Switzerland), Marco Paggi (IMT Lucca, Italy)
  - 5 presentations
- S14: Experimental mechanics
  - Julien Réthoré (EC Nantes), Rolf Mahnken (LMT Paderborn, Germany)
  - 14 presentations (+2 in the Award session)
- S15: Experimental nanomechanics
  - Christoph Kirchlechner (MPIE Dusseldorf, Germany), Frédéric Mompiou (CEMES Toulouse, France)
  - 13 presentations
- S16: The mechanics of highly porous materials: experiments and modelling
  - Patrick Onck (RU Groningen, NL), Eric Maire (INSA Lyon, France)
  - 7 presentations (+1 in the Award session)
- S17: Coupled experimental-numerical approaches in materials characterization
  - Helena van Swygenhoven (EPFL, Switzerland), David Rodney (U. Lyon, France)
  - The few papers in this session were redistributed among other sessions, and S17 was finally not organised during the conference.
- S18: Advanced modelling techniques: higher-order continua
  - Samuel Forest (Mines ParisTech, France), Swantje Bargmann (U. Wuppertal, Germany)
  - 7 presentations (+2 in the Award session)
- S19: Advanced modelling techniques: scale bridging
  - Varvara Kouznetsova (TU Eindhoven, NL), Bob Svendsen (MPIE Dusseldorf, Germany)
  - 20 presentations (+4 in the Award session)
- S20: Advanced modelling techniques: stochastics in materials mechanics
  - Régis Cottereau (Centrale-Supelec, France), Francois Willot (Mines ParisTech, France), Carsten Proppe (ITM Karlsruhe, Germany)
  - 7 presentations (+1 in the Award session)
- S21: Advanced modelling techniques: phase field and diffuse-interface approaches
  - Benoît Appolaire (U. Lorraine, France), Nele Moelans (KU Leuven, Belgium)
  - 14 presentations
- S22: Reduced order and data-driven material models
  - Benjamin Klusemann (HZ Geesthacht, Germany), Fransisco Chinesta (ENSAM Paris, France)
  - 14 presentations

EUROMECH Best Student Presentation

A special session dedicated to the competition for the EuroMech Best Student Presentation awards was organised. From the 30 competitors, the jury (composed of plenary lecturers, together with Renald Brenner and Nicolas Moës) finally selected:

- Seyed Ali Elahi for the paper entitled: A volume-based aspiration method to estimate in-vivo soft tissues stiffness: evaluation of the device with silicone samples;
- Shahed Rezaei for the paper entitled: Developing an interface model to investigate the damage and fracture in hard nano-coating layers.

The prize money offered by EUROMECH (500 EUR / award) will be complemented by a contribution from MecaMat (250 EUR / award).

ESMC10 - 10th European Solid Mechanics Conference

2 - 6 July 2018, Bologna, Italy
Chairperson: Prof. Davide Bigoni and Prof. Franceso Ubertini

The Venue and Organisers

The 10th European Mechanics Conference was held in Bologna at "Palazzo dei Congressi" from 2nd to 6th of July 2018. The "Palazzo dei Congressi" is a conference centre located not far from the city centre of Bologna and well served by bus. The congress was co-chaired by Davide Bigoni (Professor at the University of Trento, Italy) and Francesco Ubertini (Rector of the University of Bologna). Professor Stefano de Miranda (University of Bologna), Dr Giovanni Castellazzi (University of Bologna) and Mrs Nadia Borelli (Fondazione Alma Mater) strongly co-operated in the organization of the congress. Fondazione Alma Mater, the Foundation of the University of Bologna, was in charge of the organizing secretariat for the whole conference. It is a non-profit organization, operating in the sole interest of the University of Bologna. The "Palazzo dei Congressi" not only provided the premises, but also the supporting staff at the reception desk and one person in each of 20 congress rooms for the management of video projectors and assistance with the presentations. These rooms were used for 20 parallel sessions. The largest room, where all the general lectures were given and all ceremonies took place, has a capacity of more than 1300 places.

Selection and Presentation of Papers

At the close of website registration for EMSRC10, 1353 abstracts had been received, of which 1136 were accepted. The number of oral presentations was expected to be 1111, with 25 poster presentations. There were 1615 registered ESMC10 participants. Some of the participants had expressed an explicit desire to present a poster instead of an oral presentation. The oral presentations were organised into 9 General Sessions and 20 parallel sessions. All 20 parallel sessions of the congress run smoothly and only a few expected presentations did not take place. The participation was very high with many rooms full of participants. The poster session took place on Thursday from 12:15 to 13:45 during the lunch break and was held in the lunchroom to facilitate participation. A prize was given for the best poster presentation.

Mini-Symposia

There were 55 mini-symposia (MS), involving 136 organisers. Following a request from the organisers, MS 3.12 and MS 6.1 were merged into one mini-symposium.

Registration and Social Programme

Although the congress started officially on Monday morning at 08:30, registration began on Sunday afternoon at 14:00, so that no delays or queues occurred on Monday morning. There was a welcome reception on Monday evening and lunch and two coffee breaks were provided on each day. A dinner for mini-symposium organisers was held on Wednesday, July 4 at "Cantina Bentivoglio", a restaurant in the city centre of Bologna, with 98 participants. The main social dinner for 928 ESMC10 participants was held in the "Palazzo Re Enzo" a beautiful historical building (700 years old) located in the central plaza of Bologna. A free bus service from the "Palazzo dei Congressi" was made available, so that participants did not have to leave the conference early. During the dinner, guests were entertained by a presentation, pianist and a guitar exhibition. Young Scientist awards and the Best Poster award were announced during the dinner. Afterwards, a cocktail bar was freely available to all participants.

Opening of the congress

The congress was open on Monday morning at 09:30. D. Bigoni chaired the session, F. Ubertini addressed a brief welcome to the participants, M. Geers (the next President of Euromech) gave a 10 minutes talk about the EUROMECH society, A. Corigliano (chairman of the Congress Committee) showed data on the participation in the congress and finally D. Bigoni gave some practical information. The opening session terminated at 10:00 with the general lecture given by K. Bertoldi.

Young Scientist Awards

According to the rules provided by the Congress Committee, two sessions on Monday were reserved for the Young Scientist competition. Some members of the Congress Committee (plus one of the organisers, D. Bigoni) were present to assess the quality of the talks. All presentations were found to be of high quality. At the end of the sessions the three best-presented papers were discussed and voted on, as described in a report prepared by Peter McHugh.

EUROMECH Fellows

The Euromech ceremony took place on Wednesday from 12:30 to 13:00, and was chaired by D. Bigoni. The presentation of the Euromech Fellows and the laudations were given by Dick van Campen (President of the Award Committee) and by Stephanie Reese (Euromech Treasurer). All three new Euromech Fellows, namely W. Curtin, S. Forest, and W. Wall, were present.

General Lectures

Six general lectures were given by K. Bertoldi (Harvard University), R.W. Ogden (Glasgow University), O.S: Hopperstad (Norwegian University of Science and Technology), Z. Suo (Harvard University), B. Schrefler (University of Padova), T. Pardoen (Ecole Polytechnique de Louvain). They were highly appreciated by the participants.

Solid Mechanics Prize

The Solid Mechanics Prize was presented on Friday morning at 09:00 to Erik van der Giessen by Dick van Campen, who briefly described the scientific achievements of the winner. The session was chaired by A. Needleman and the prize was assigned before the talk by Pierre Suquet and Dick van Campen. The prize lecture was highly appreciated by a large audience, notwithstanding the fact that the lecture was given on the last day of the Congress.

Congress Closure

The closure of the congress was held, according to the programme, on Friday afternoon at 15:45. There was a brief presentation by Peter McHugh on the location of the next ESMC that will be held in Galway (Republic of Ireland) in 2021. A. Corigliano (Chairman of the Congress Committee) then gave a brief summary of the conference, described the composition of the ESMCC starting from January 2019 and offered congratulations for the effective organization of ESMC10. A final acknowledgement to people who helped in the congress organization was given by D. Bigoni.

Conclusion

ESMC10 confirmed that Solid Mechanics is an active research field, involving many young scientists and research teams from all the world. Solid Mechanics embraces a number of topics, so that it contributes to a series of technological developments and research challenges.

Suggestions for the Future

In order to increase participation in the Euromech Fellow Session, it should occur it just after or before a plenary session. The decisions to increase the number of Young Scientist awards to three and to present a prize for the best poster were highly appreciated. it is therefore suggested that this arrangement should be continued.

EFMC12 - 12th European Fluid Mechanics Conference

9 - 13 September 2018, Vienna, Austria
Chairperson: Prof. Hendrick Kuhlmann

Organisation

The conference was organised jointly by Technische Universität Wien (TU Wien) and the Institute of Science and Technology Austria (IST). The local organizing committee was chaired by Hendrik C. Kuhlmann (TU Wien), while scientific guidance was provided by the European Fluid Mechanics Conference Committee (EFMCC) headed by Roberto Verzicco (Università di Roma).

Participation and Venue

Owing to the large number of more than 900 submitted abstracts the selection criteria applied by the EFMCC were rather strict and about 800 abstracts were accepted for presentations. EFMC12 was attended by 805 delegates from 41 countries with 48 accompanying persons.

The conference started with a Get-together at the Orangery of Schönbrunn Castle on Sunday afternoon. On Monday morning the Opening Ceremony took place at the Wiener Konzerthaus, one of the three iconic places among the Wiener Staatsoper and the Wiener Musikverein which have founded the reputation of Vienna as the city of music. Welcome addresses were delivered by the chairman of EFMC12, the Rector of TU Wien, and the Dean of the Faculty of Mechanical and Industrial Engineering of TU Wien. As a third social event, participants could enjoy a reception on Wednesday by Omar Al-Rawi, a member of the State Parliament and Communal Councillor of Vienna, which was followed by the conference dinner in the ballroom of the Mayor's House.

Programme

The scientific programme covered all aspects of fluid mechanics with emphasis on its fundamentals. Scientific sessions were organised under the topics:

- Aeroacoustics;
- Biological flows;
- Compressible flows;
- Control and drag reduction;
- Convection;
- Drops and bubbles;
- Electrohydrodynamics;
- Engineering flows;
- Experimental techniques;
- General fluid dynamics;
- Geophysical flows;
- Granular flows;
- Instability;
- Interfacial flows;
- Jets;
- Magnetohydrodynamics;
- Microscale flows;
- Multiphase flows;
- Nonlinear dynamics;
- Numerical methods;
- Particle-laden flows:
- Porous media;
- Reactive flows;
- Rheology;
- Rotating flows;
- Turbulence;
- Vortex flows;
- Waves;
- Wetting and capillarity.

The contributed papers were presented in a total of 105 sessions, 14 in parallel, which took place at three close-by venues in the centre of Vienna with most lecture halls being located at the Freihaus of TU Wien.

Invited Talks and Prize Lecture

Including the Fluid Mechanics Prize Lecture by Javier Jiménez, a total of eight invited talks were delivered. The seven keynote lecturers were: Lyderic Bocquet, Claudia Cenedese, Björn Hof, Eric Lauga, Miguel Onorato, Jörg Schumacher, and Todd Squires.

Mini-symposia

Six mini-symposia were organised on the topics:

- Biomechanics of swimming and flying and bio-inspired propulsion;
- Flows in porous media;
- Fluid mechanics of particles at interfaces and surfactants;
- Magnetic fluids;
- Perturbation techniques in fluid mechanics;
- Sedimentary flows and patterns.

Young Scientist Awards

During the Closing Session on 13 September, the winners of the Young Scientist Awards were announced:

- Ambre Bouillant (Ecole Polytechnique and ESPCI) for “Leidenfrost thermophobic wheels”;
- Adrien Lefauve (University of Cambridge) for “The structure and origin of confined Holmboe waves”.

EUROMECH Colloquia Reports 2018

EUROMECH Colloquium 593
"Plasma-based actuators for flow control: recent developments and future directions"
14 – 16 March, 2018, Delft, The Netherlands
Chairperson: Marios Kotsonis
Co-Chairpersons: Nicolas Benard, Eric Moreau

Introduction

Plasma-based actuators have received considerable attention from the flow control community in recent years. Their high dynamic range, robustness and simplicity render them ideal for the emerging field of active flow control for improvement of aerodynamic performance. Fields of application include aerospace platforms, high lift systems, wind energy and internal turbomachinery flows. Several types of plasma-based actuators have been developed and tested. Considerable advancements in modelling, characterisation and application of this type of actuator have been demonstrated in both laboratory and industrial scales. Yet several open issues remain in all the above topics, which necessitate further developments in order to ensure full-scale industrial adoption of these systems. EUROMECH Colloquium 593 provided an open and informal platform for discussion and exchange of ideas between leading scientists in Europe but also worldwide.
This was the first dedicated EUROMECH colloquium on plasma actuators. The colloquium offered the opportunity for researchers to present their numerical, experimental and theoretical work on suggested topics.

Topics

Characterisation of plasma-based actuators. Characterisation studies are essential towards elucidating the underlying physical processes governing the operation of plasma actuators. Additionally, they provide insight into the effect of operational parameters (geometry, materials, electrical power etc.) on the performance of the actuator. Contributions focused on recent characterisation studies, encompassing mechanical, electrical and thermal properties of plasma actuators. Specific discussion areas included:

- Mechanical (thrust and velocity) measurements (AC-DBD, DC corona, spark);
- Electrical (power, discharge regime, spectroscopy) (all types) characterisation studies;
- Thermal characterisation (spark, ns-DBD);
- Body-force extraction techniques (AC-DBD, DC-corona);
- Influence of ambient conditions on performance (all types;)
- Development of plasma-based actuators.

By extending the basic morphology of the different types of plasma actuators, several variations were proposed, towards improving or altering the performance. Novel concepts based on new materials, geometries, power supplies etc. were proposed. Additionally, attention was given to aspects such as reliability, robustness, and manufacturing techniques, which might not affect the performance of the actuators but certainly enhance their industrial application potential.

- New actuation concepts (configuration, geometry, waveforms, power supplies)
- New materials (electrodes, dielectrics)
- New manufacturing techniques (printed actuators, deposition techniques, materials)
- Modelling of plasma-based actuators
- Numerical and theoretical modelling of the operation of plasma actuators is necessary towards understanding the dynamic plasma formation processes.

Additionally, simplified models of the actuators (i.e. body force distributions for ACDBD actuators) are indispensable for the account of their effect in CFD simulations. Work presented under this topic focused on a wide range of models spanning from analytical or phenomenological to highly complex first-principles models, for all types of plasma-based actuators.

- Analytical and phenomenological models;
- Hybrid models;
- First-principles models;
- Application of plasma-based actuators.

Finally, plasma actuators are intended for active flow control. In this topic, focus was given on application cases in laboratory and industrial conditions. The session covered laboratory flow control objectives, such as lift enhancement or drag reduction. Additionally, industrial application efforts were presented. These included:

- Lift and drag control;
- Laminar-turbulent transition control;
- Turbulent flow control;
- Noise and jet control;
- Wind energy applications;
- Internal flow applications;
- Industrial application cases.

EUROMECH Colloquium 594
"Bone remodelling: multiscale mechanical models and multiphysical aspects"
15 – 19 May 2018, Nancy, France
Chairperson: Jean-François Ganghoffer
Co-Chairperson: Michal Nowak

Introduction

The classical picture of turbulence which has prevailed since the pioneering works by Kolmogorov, Prandtl and others from the first half of the last century is that turbulent fluid motion is characterized by a cascade of vortices and swirls of different sizes that give rise to a featureless and stochastic fluid motion. Our daily experience shows, however, that open and closed turbulent flows in nature and technology are often organised in prominent large-scale and long-living structures, which are called turbulent superstructures. These large-scale structures dominate the global transport of mass, heat and momentum; they act as barriers to transport and they increase the variability and fluctuations in the flow.
The analysis of turbulent superstructures is now possible due to significant advances in measurement techniques, numerical simulation, and mathematical characterization. Tomographic laser-based measurement techniques can track the dynamics of turbulent structures with unprecedented resolution in space and time. Direct numerical simulations on massively parallel supercomputers have advanced to a level where turbulent flows in extended domains can be simulated at sufficiently high Reynolds numbers and in parameter ranges where superstructures emerge. Efficient Eulerian and Lagrangian methods to characterize dominant vortices and flow structures, as well as determining the transport across their boundaries, were developed in applied mathematics. Computer science provides efficient algorithms for the visualization of structures in very large data sets.
The goal of EUROMECH Colloquium 594 was to exchange new results on the structure and physics of turbulent superstructures and to discuss future directions in this field of turbulence research among scientists from applied mathematics, physics, engineering and computer science. The colloquium programme thus included recent experimental and numerical results on the processes that generate and sustain turbulent superstructures, on their dynamics, the transport across their (relatively sharp) interface and their impact on turbulent flow properties in simple open (e.g. boundary layers) and closed flows (e.g. pipe flows, Taylor-Couette flows or Rayleigh-Bénard convection). The focus of the presentations was on simple flow geometries.
For each of these specific topics, a keynote presentation was scheduled (45 minutes presentation time plus 15 minutes discussion time). The five invited keynote speakers are well-known experts in their research fields and beyond:

- Kathrin Padberg-Gehle, Lüneburg reported on the Lagrangian analysis of transport by coherent sets and/or turbulent superstructures;
- Ivan Marusic, Melbourne and Javier Jimenez, Madrid on new statistical detection methods of turbulent superstructures and the connection of superstructures to smaller vortices and packages of vortices near the walls;
- Themistoklis Sapsis, Cambridge, USA discussed the role of large-scale extreme events for the global statistics in turbulent flows and presented new strategies to predict their appearance, which are based on the solution of an optimization problem.
- Jerry Westerweel, Delft gave a keynote presentation on the dynamics in the vicinity of turbulent/non-turbulent interfaces. Recent experiments and simulations determined the so-called viscous small-scale nibbling as the main mechanism of transport across sharp interfaces. These interfaces are considered as transport barriers that surround turbulent superstructures.

In addition to the 5 keynote talks, 13 contributed talks lasting 30 minutes and 11 short talks lasting 20 minutes were scheduled. There were also 10 poster presentations in a session during the first evening of the meeting. The schedule of the colloquium was set up so that there was sufficient time for mutual and group discussions during the breaks between the sessions and over meals. The outcome of these discussions was summarized at the end of the meeting.
Specific open topics and resulting future tasks were identified during the course of the colloquium, which can be grouped and summarized as follows:

Detection of turbulent superstructures

Which Eulerian and Lagrangian methods are suited best to detect turbulent superstructures and which new experimental and numerical techniques are necessary to monitor the structures in space and time? How important are spatial and statistical symmetries for the detection of superstructures? Are there new tools to compress the information of vector and tensor fields which are derived from the flow modeling effectively? The Related talks were by: Marusic, Melbourne; Encinar, Madrid; Weiss, Göttingen; Scheel, Los Angeles; Bross, München; Oberlack, Darmstadt; von Larcher, Berlin.

Origin and mechanics of turbulent superstructures

What is the dynamical origin of turbulent superstructures? Can they be traced back to exact coherent states and/or primary flow instabilities? How sensitively do turbulent superstructures depend on specific boundary conditions in the flow system? Are superstructures composed of a whole hierarchy of smaller-scale structures? How are superstructures connected to extreme events? Related talks: Jimenez, Madrid; Hwang, London; Wesfreid, Paris; Blass, Twente, Sapsis, Cambridge, USA; Pausch Marburg.

Transport by turbulent superstructures

How much do turbulent super-structures contribute to the global turbulent transport? How important is the superstructure interface as a transport barrier? How precisely can the interface of a turbulent superstructure be resolved by Lagrangian methods? Related talks: Padberg-Gehle, Lüneburg; Karrasch, München; Öttinger, Zürich; Westerweel, Delft.

Reduced modelling and control

What are efficient ways to reduce the number of degrees of freedom to describe superstructures? Which strategies can be applied to control turbulent superstructures, i.e. to stabilize such structures in a turbulent shear flow? Related talks: Schlatter, Stockholm; Feldmann, Bremen; Gerlach, Paderborn.

From this list of open points, it becomes clear that many questions which are related to turbulent superstructures are far from being completely answered. They will require further joint interdisciplinary efforts. There is now a priority programme on this subject, funded by the Deutsche Forschungsgemeinschaft.

Colloquium 586 was successful and fruitful. It provided a format which allowed us to summarize the current progress in the field and to generate new momentum and ideas for future research. The three organizers of the colloquium would therefore like to thank EUROMECH for making this colloquium possible.grateful for financial support from the Russian Foundation for Basic Research.

EUROMECH Colloquium 596
" Numerical simulations of flows with particles, bubbles and droplets"
9 – 11 May 2018, Venice, Italy
Chairperson: Luca Brandt
Co-Chairpersons: Francesco Picano, Outi Tammisola

Introduction

The aim of EUROMECH Colloquium 596 was to discuss the latest advances in numerical simulations of flows with particles, bubbles and droplets, and new possible interactions between experiments and simulations aiming to best exploit these advances. Indeed, the development of high-fidelity numerical algorithms and computational power has recently enabled fully resolved simulations of suspensions of rigid and deformable particles, two-fluid systems and elastic/porous media, including heat and mass transfer, phase change and different short-range interactions, e.g. depletion forces. These studies are becoming more frequent and have received a significant attention. It is well recognized that the biggest new development in multiphase flow research has been the use of interface-resolved simulations and that these simulations are already starting to have a major impact for modelling as well as for gaining new fundamental insights. However, we are still exploring the potential of these new tools and how to take advantage of and complement the parallel development of new experimental techniques; there are therefore many opportunities to improve our understanding of the different physical processes involved. The challenge is to best exploit the new capabilities, collect results for more and more complex systems and advance the modelling of these systems.

Participation

About 55 scientists attended the meeting. There were about 50 high-quality talks; among those were three keynote lectures by Prof. Jochen Fröhlich, Prof. Christian Poelma and Prof. Sebastien Tanguy. In addition, Prof. Alfredo Soldati, Editor in chief of the International Journal of Multiphase Flows, coordinated a final concluding discussion on the perspectives in this research area.

Programme

The first day of EUROMECH Colloquium 596 dealt with particle-laden flows. It started with presentations and discussions on finite-size particles in turbulence: the role of rotational motion and particle size, shape, as well as enhanced heat transfer effects, turbulence modulation for more dilute systems (two-way coupled systems), both with finite-size and point particles. The rest of the afternoon was dedicated to computational modelling: multiphysics aspects (water droplets in clouds, reacting flows, rarefied gases), and subgrid-scale modelling. Finally, the specific computational challenges related to contact lines in three-phase systems such as particle-drop interactions, contacts with solid surfaces, and complex geometries were discussed.

The second day focused on bubbly flows and droplet-laden flows, with presentations on methods to accurately predict coalescence and breakup, droplet collisions, and the effect of surfactants.
Both Eulerian and Euler-Lagrange based methods were discussed, in particular diffuse interface methods. The invited talk introduced experimental challenges in multiphase flow measurement due to opacity and what quantities can be measured in dense flows. To be consistent, the afternoon was dedicated to studies concerning comparisons between experimental and numerical results, and the associated challenges.

The third day of Colloquium 596 started with the invited talk by Sebastien Tanguy about liquid vapour phase change in the presence of external flows. The day was then dedicated to simulating and modelling the physics of complex multiphase flows. The first session discussed non-Newtonian effects such as viscoelasticity-induced ordering, and collective motion of micro-organisms. The second session focused on non-isothermal flows, such as drag reduction under non-isothermal conditions and heat transfer in particle beds.

Conclusion

The scientific discussions during EUROMECH Colloquium 597 resulted in various consensus statements:

- The attendees agreed that purely data-driven surrogation, excluding mathematical structure and physical laws, will likely not lead to the anticipated predictivity and robustness. Another concern was the weak transferability of machine learning based predictions for complex material behaviour. Extensive data generation and time-consuming parameter adjustment without physical guiding was not seen as an attractive option.
- The extension of error estimation and control to highly nonlinear and path-dependent problems remains a massive challenge. The key problem in this regard is related to the computational demands of the estimators which can easily make up for the distinct savings of reduced order models and which renders the error estimation computationally unattractive.
- The attendees agreed that the interaction of data-driven modelling using deep learning, sparse tensor decompositions and alike should be combined with dedicated physical and mathematical approaches. There was an overall agreement that using intelligent data-processing can complement but not completely substitute the

other developments. The development of hybrid techniques is seen as a key goal for the next years.

The feedback given by the guests was very positive and the organisers concluded that the event was successful in bringing into contact scientists from different geographic areas - i.e. across Europe and beyond - as well as from a range of disciplines that included mathematics, engineering and computer science. The audience consisted of a well-balanced mix of masters and doctoral students, post-docs and established professors. The communication barriers within the group were low, which led to many interesting in-depth discussions.
Several bilateral co-operations were initiated and existing collaborations were deepened.
With a view to future activities, a special issue in "Mathematics and Computational Applications" entitled "Machine Learning, Low-Rank Approximations and Reduced Order Modelling in Computational Mechanics" will be produced with the Colloquium chairpersons as guest editors. Several participants committed to submitting manuscripts for this special issue. The chairpersons also decided to propose a follow-up workshop (also in the spirit of their previous workshops WORM2013, WORM2014 and WORM2016) with the particular objective of maintaining continuity of participants and preserving a good balance of young, intermediate and senior scientists.
The organisers gratefully acknowledge EUROMECH's financial support, which helped in keeping the colloquium fee at a low rate and encouraging wide participation. Additionally, the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) supported the invitation of guests for the workshop under grant DFG FR2702/6 within the Emmy-Noether programme.

EUROMECH Colloquium 599
"Coherent structures in wall-bounded turbulence: new directions in a classic problem"
29 – 31 August 2018, London, UK
Chairperson: Yongyun Hwang
Co-Chairperson: Bruno Eckhardt, Javier Jimenez, Rich Kerswell

Programme

EUROMECH Colloquium 598 was focused on three key areas. These were:

- Transition (first day);
- Turbulence in canonical flows (second day);
- Flow control, model reduction and complex flows (third day);
- The colloquium concluded with a discussion chaired by Prof. Mike Graham.

Transition

Computation of exact coherent states (equilibria and periodic orbits) is becoming routine. There is now a focus on unveiling the dynamics of transition. This includes studying dynamically relevant manifolds linked to the known exact coherent states (e.g. homoclinic tangency), bifurcation of spatio-temporally localised exact coherent states, and stabilising/controlling the edge of turbulence. They are also accompanied by development of low-dimensional models which capture the transition dynamics phenomenologically.

Turbulence

Attached eddy hypothesis, which assumes the self-similar organisation of coherent structures, now appears to be accepted as the common theoretical ground for description of coherent structures. There have been dedicated efforts to combine the notions of linear/nonlinear dynamical systems theories with attached eddy hypothesis (resolvent mode, impulse response, quasi-linear analysis/statistical dynamics approach, exact coherent states, and novel statistical technique based on causality) with coherent structures observed in high Reynolds Number turbulence. The use of a machine learning theory with massive computational effort was also proposed to avoid missing important dynamics.

Flow Control

The third day covered a broad range of topics more generally applicable to complex flows, including flow control and model reduction. Flow control and model reduction techniques appear to be fairly complete in the linear regime and effort is now focused on extending these notions to highly chaotic flows. Studies include sensitivity calculation of chaotic state, computation of new periodic orbits with DMD, optimisation problem and exact coherent states at high Re, and novel modal decomposition techniques for nonlinear flows. There were also some presentations on turbulence control with spanwise wall-oscillation, studying duct flows and asymptotic analysis of transition.

Discussion

The discussion session was chaired by Prof. Mike Graham, and raised a number of issues for future consideration:

- Fluid dynamical relevance of periodic orbits for high Re turbulence;
- Relevance of hairpin vortices;
- Attached eddy hypothesis: where to go further;
- Outlook for low-dimensional modelling (quasi-linear approximation, in particular);
- Flow control and state space information;
- The role of the wall in wall-bounded flows.

EUROMECH Colloquium 599
"Rotating convection: from the lab to the stars"
28 May – 5 June 2018, Leiden, The Netherlands
Chairperson: Rudie Kunnen
Co-Chairperson: Stephan Weiss

Introduction

Thermal buoyancy is arguably the largest dynamic force in the universe, driving many planetary and stellar flows. These flows are almost invariably further shaped by the influence of axial rotation of their celestial bodies. Convective systems are generally too complex and too vast for a full direct simulation and too large and too remote for direct measurements. The recent development of asymptotically reduced mathematical models and upcoming experiments studying these flows in a simplified form have opened up new perspectives to get a better grip on such flows that shape our universe. The aim of EUROMECH Colloquium 599 was to bring geo- and astrophysicists in contact with scientists studying fundamental fluid dynamics, to bridge the gap from the lab to the stars.

Programme

During the workshop the twelve keynote lectures set the stage by giving broader introductions to relevant subfields: from simplified but well-controlled, readily-accessible laboratory experiments, to accompanying direct numerical simulations of various levels of complexity in terms of geometry and involved physical processes, from rigorous mathematical analysis to observational work. Next to these keynote lectures there were 24 shorter oral contributions by senior participants and poster contributions from junior participants. The organisers were pleasantly surprised to see that, despite the breadth of the studied topics, the "language" of each field was easily understood by the other participants. This was readily apparent in the lively discussion sessions, with ample input from the various fields represented in the workshop.

Discussion

In the discussion sessions many new perspectives for laboratory experiments were sketched. The experiments are moving beyond integral measurements (overall heat transfer) to more localized diagnostics, like in situ temperature measurements and optical flow measurements using techniques such as particle image velocimetry or Lagrangian particle tracking. There is a great need for these more advanced flow statistics. Additionally, many suggestions for experiments move on from canonical simple geometries toward more complex situations involving geometrical effects (e.g. spherical shells with rapid centrifugation for gravity) and/or extra physics such as multiphase and double-diffusive media, or magnetic fields in liquid metals.
For numerical simulation the development of the asymptotically reduced equations has brought a means to connect smaller-scale laboratory experiments and full direct simulations to actual geo- and astrophysical flows. The connection of asymptotics and direct simulations/experiments is now being made, with favourable comparisons on display during the workshop. Now the challenge is to add other physical effects (change geometry from a plane layer, involve a magnetic field, etc.) to these equations. Comparisons with cutting-edge direct simulations of the full equations will be required here for proper validation and to delineate the range of validity of the asymptotic equations.
It is unfortunate that traditional subgrid-scale approaches (typically assuming isotropy and exploiting the notion of a downscale cascade of energy) cannot be applied to these systems given that rotation leads to strong anisotropy and scale separation. Small-scale features are active and cannot be filtered out. There may also be an inverse energy cascade, further complicating the picture. Mathematical analysis (e.g. upper bound analysis of heat transfer) is also facing problems in that rotation does not contribute directly to the traditional energy-based approaches. However, for both these approaches some out-of-the-box ideas came up that may still lead to progress.
The meeting has fostered new collaborations and many new research ideas have emerged over the course of the week. The community plans to organise a follow-up meeting in the United States in about two years' time to assess progress.
The organisers thank the Lorentz Center for outstanding organisational support, both before and during the workshop. They also gratefully acknowledge the financial support of EUROMECH, Lorentz Center, NSF, DFG, ERC and J.M. Burgers Centre.

EUROMECH Colloquium 601
"Micromechanics of Defects in Crystalline Solids and Metals"
11 – 15 June 2018, Sevilla, Spain
Chairperson: Pilar Ariza
Co-Chairperson: Viggo Tvergaard, Michael Ortiz

Introduction

Recent developments in experimental science that enable the examination of defects at the atomic scale provide an unprecedented connection between the structure and properties of materials. Techniques ranging from high-resolution electron microscopy to atomic-force microscopy reveal new insights into the micromechanical foundations of material behaviour, but also pose deep challenges as regards theory, modelling and simulation. However, the link between the defects themselves and the observed macroscopic behaviour is often a difficult one to forge theoretically or computationally and remains an active area of research.

Many of the fundamental mechanisms underlying the inelastic behaviour and failure of materials are mediated by crystal-lattice defects and are, therefore, accessible to direct atomistic simulation, either by means of empirical potentials or through ab initio quantum-mechanical calculations. Notable examples are furnished by first principles calculations of the EoS and elastic moduli of metals up to high pressures and temperatures, and the characterization of the structure of point defects, such as vacancies and interstitials, and extended defects, such as dislocations, grain boundaries and cracks.
However, in general atomic-scale mechanisms are separated from macroscopic behaviour by a vast array of intervening continuum scales. These mesoscopic scales both average and set the boundary conditions or driving forces for the atomic-scale phenomena and are an essential part of the structure of materials. While effective at describing macroscopic material behaviour, continuum theories tend to break down on the scale of the lattice, e. g., in the vicinity of lattice defects. Therefore, a complete understanding of material behaviour and failure, as well as the predictive computation of the material properties, requires both atomistic and continuum modelling, with the atomistic/continuum handshake most effectively achieved within the framework of multiscale modelling.

Participation

The goal of EUROMECH Colloquium 601 was to bring together a diverse group of Scientists from various areas ranging from theoretical, experimental and computational modelling of the mechanics of materials. Altogether there were 47 participants and 39 presentations. The list of participants and the full programme are available in a separate document.

Most importantly, there was ample time for informal discussions between the participants during coffee breaks, lunches and social activities.

Topics

Specific topics addressed in the talks and discussed subsequently included:

- Elastic defects and configurational forces;
- Effective/homogenized properties of composites;
- Mixed continuum/atomistic/DFT models;
- Diffusive molecular dynamics and mass transport;
- Two-dimensional/multifunctional materials;
- Dislocation dynamics and crystal plasticity;
- Multiscale modelling and simulation of polycrystals;
- Multiscale models of microstructure evolution;
- Multiscale/regularized models of brittle damage/fracture;
- Ductile fracture and crazing;
- Multiscale modelling of cell/tissue mechanics;
- Continuum thermodynamics models of inelasticity;
- Acknowledgements.

The organisers thank EUROMECH and the University of Seville, especially the Engineering School, for making the meeting possible and for financial and organizational support.

EUROMECH Colloquium 603
"Dynamics of micro and nano electromechanical systems: multi-field modelling and analysis"
11 – 15 June 2018, Sevilla, Spain
Chairperson: Pedro Ribeiro
Co-Chairperson: Stefano Lenci and Sondipon Adhikari

Introduction

EUROMECH Colloquium 603 was devoted to the discussion of the state of the art and future perspectives in the analysis, characterization, modelling, application and design of electromechanical dynamical systems with dimensions of a few micro or nanometres. This is a very relevant topic since, due to the recent progress in micro and nanotechnology, small-scale electromechanical systems are becoming increasingly common in various disciplines of engineering and applied science. Furthermore, micro and nano electromechanical systems open a number of exploratory research areas in science and engineering, due to the necessity of joining diverse fields of applied sciences or to consider issues that are not noticeable at macro scales. Applications of these small-scale systems often require knowledge of their dynamic behaviour.

Participation

47 Scientists, from 19 countries, participated in EUROMECH Colloquium 603. Three invited lectures and 41 regular communications were delivered. Analytical, numerical and experimental studies were presented and discussed.

Programme and Discussion

47 Scientists, from 19 countries, participated in EUROMECH Colloquium 603. Three invited lectures and 41 regular communications were delivered. Analytical, numerical and experimental studies were presented and discussed.
Programme and Discussion
The following topics were addressed in the presentations:

- Modelling of small-scale structures, from non-classical continuum theories to atomistic-based models;
- Multi-field problems at small length scales, including the analysis of structural elements under piezoelectric or electrostatic sensing/actuation, subjected to thermal fields or interacting with fluids;
- Linear and, chiefly, non-linear dynamics of diverse micro and nano electromechanical systems.

Presentations on related topics, such as the properties and failure of nanostructures and CNT reinforced composites, also took place. There was time for discussions, namely after each presentation, during breaks, throughout the social programme, and in the closing session. Some issues considered in these discussions are mentioned in the following paragraphs, in a general overview. More detailed analysis can be found in the extended abstracts and short papers published in an electronic book of proceedings (ISBN 978-989-746-185-9). Papers based on some contributions presented at Colloquium 603 will be published in a special issue of the International Journal for Non-linear Mechanics.

Discussion

Many participants in Colloquium 603 felt that non-linearities are not, as was considered for many years, something to avoid. Instead, non-linearities represent an opportunity to improve performances in existing devices and for the realisation of new ones. There appears to persist, nonetheless, some resistance from industry to adopt non-linear systems and non-linear analyses, possibly because industry is often averse to change and gives emphasis to reliability. On the other hand, maybe the research community should look more often into practical outcomes of nonlinear dynamics. The importance of bringing the Mechanics and Physics communities in touch was also highlighted.

Still in connection with non-linear behaviour, the importance of dynamical integrity was stressed in discussions. The fact that theoretical predictions, as saddle node bifurcation, cannot exactly be reached in practical experiments should be taken into account in identification algorithms.
The relevance of damping, how to model it and in particular, whether non-linear effects ought or not to be included in damping models, were other points discussed.
The topic of non-classical continuum theories for small scale structures was an issue of contention. Some Scientists believe that these theories are sound, theoretically, under the hypothesis they are based upon, but depend on parameters that are not easy to identify. Others think that there are so many uncertainties at small scales, that it is not very useful to implement these theories.
It appears to the organisers that a colloquium on this or a closely related topic would be appropriate within two years.

Conclusion

The organisers would like to thank EUROMECH, FEUP, the University of Porto and Santander Bank, the secretariat, the authors, the participants, the scientific committee and the reviewers for all their contributions to the success of this meeting.